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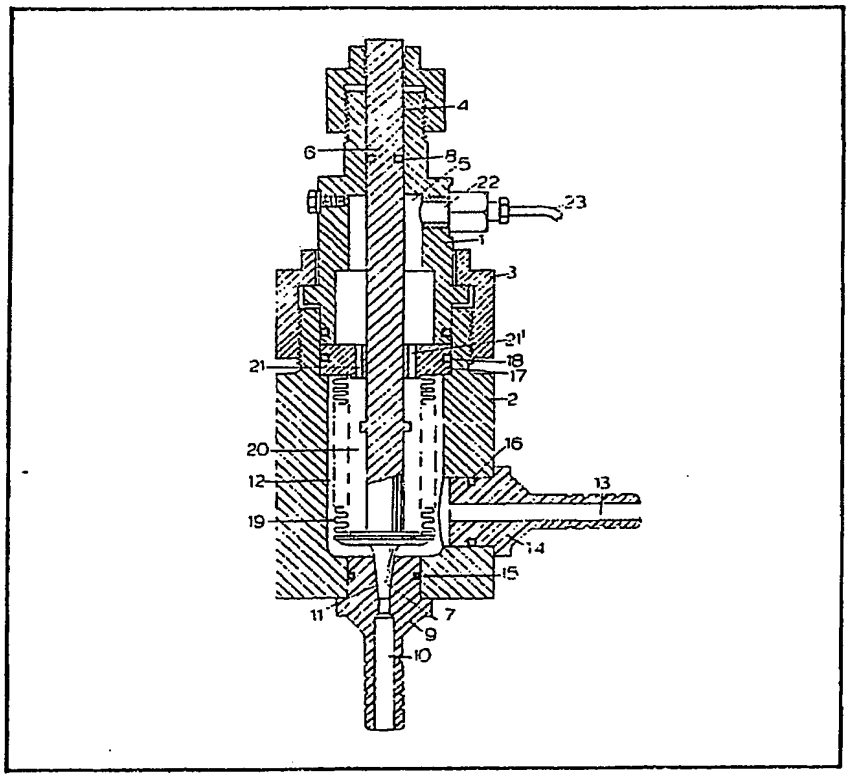
(71) Applicant
The Secretary of State for Defence, Whitehall, London SW1A 2HB
(72) Inventors
Stanley James Hawkins,
Colin Frank Paxton
(74) Agent
A. O. Bowdery

(54) **Valve for Sensitive Fluids**

(57) A valve for controlling the flow of a sensitive or explosive fluid such as nitroglycerine, likely to cause contamination, has a bellows (19) or a diaphragm attached to the valve housing and to the spindle 6 or the valve closure member 7 so as to define a chamber 20 which is filled with a desensitising fluid, the valve being provided with means to detect any leakage of the sensitive fluid into the chamber 20. The detection means consists of a pressure sensing device for indicating changes in the pressure of the desensitising fluid, for example a U-tube manometer with liquid level detectors beyond its normal range of operation. In a preferred embodiment the movement of the valve is damped by the restricted flow of the desensitising fluid through small bore channels (21, 21'). In this way safe operation is guaranteed under normal conditions and safeguards are provided to protect against and warn of any breakdown.



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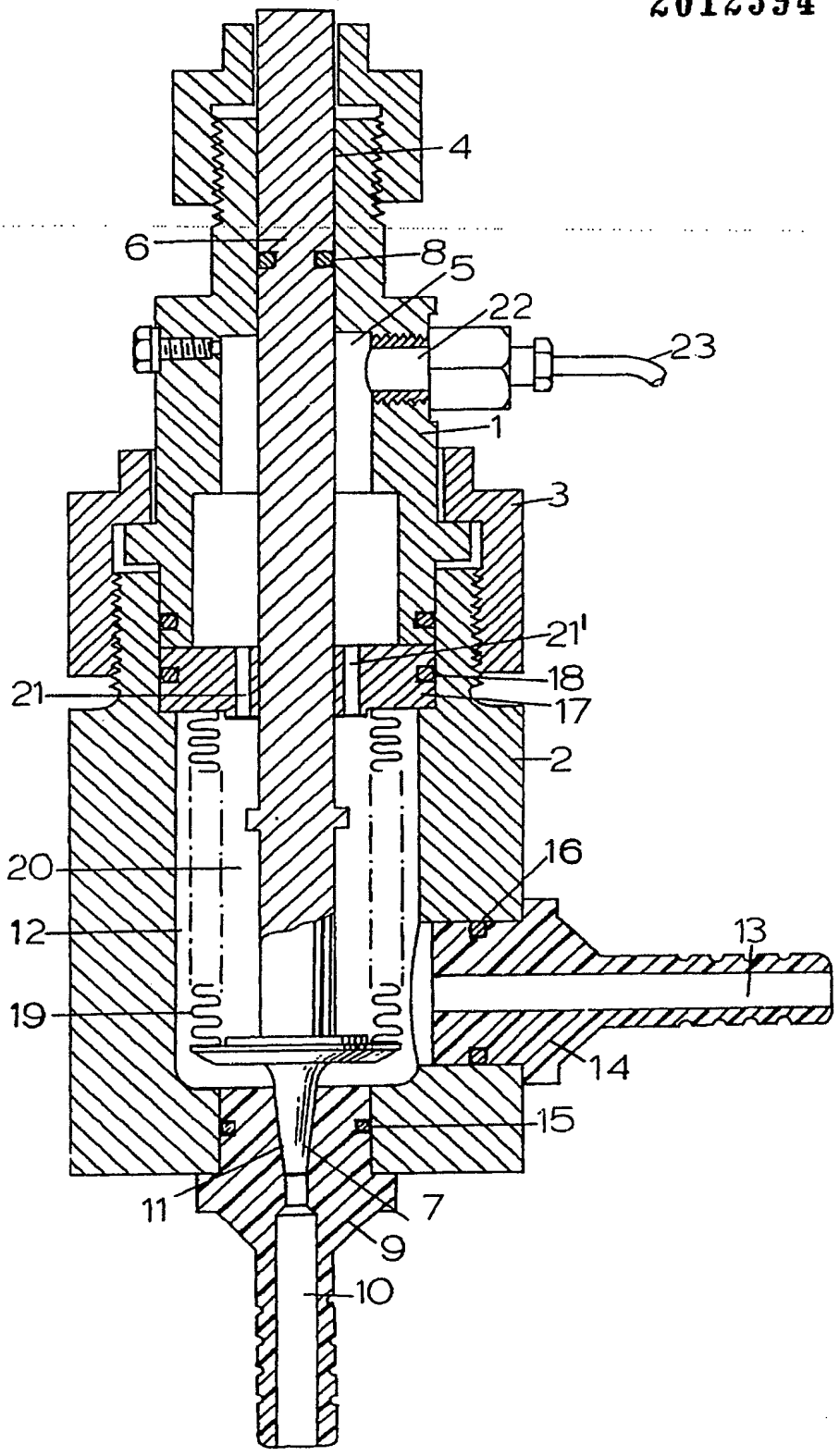

SPECIFICATION

Valve for Sensitive Fluids

The present invention relates to a valve assembly for controlling the flow of a liquid in which the liquid is kept from contact with bearings for the valve.

In the case where the flow of a sensitive or metastable or otherwise hazardous liquid, such as nitroglycerine liquid, is to be controlled, it is desirable from the point of view of safety of operation, to ensure that the liquid does not come into contact with surfaces (particularly of metal parts) of the valve equipment which rub one against the other leak through the bearing to produce contamination of the surroundings. Thus in the case where the valve member is remotely operated from outside the valve assembly via a spindle running through a bearing of some kind in the wall of the assembly it is expedient with such liquids to seal off the liquid from the bearing. Valves in which this sealing is effected by bellows have been previously described.

We have however now devised a particularly effective way of sealing a valve in which at the same time, failure of the preventive means is also protective against. Accordingly the present invention provides a valve assembly for controlling the flow of a sensitive (as herein defined) flowing fluid material, which assembly comprises a chamber having an inlet and an outlet through which the fluid material to be controlled may pass, a valve member cooperative with either the inlet or the outlet to control the flow of said fluid material, a valve spindle attached to the valve member for actuation thereof, said valve spindle extended to the outside of the valve chamber through an opening therein, sealing means disposed within the chamber and attached to the valve spindle or member and to a wall of the chamber to form an enclosure around said spindle, which enclosure is sealed off from said chamber and may receive a fluid material which is a desensitizer (as herein defined) for said sensitive fluid material, and means for indicating changes in the pressure of such fluid material within the enclosure.

The term "sensitive" used herein is intended to include any material which is unstable or, metastable, hazardous or liable to decompose under only moderate conditions which would produce undesirable or dangerous contamination of the surroundings in the event of leakage, or which is highly reactive towards a wide range of materials, or, in other words, any material which requires care in handling. The term "desensitizer" applies to any corresponding material which will stabilize the sensitive material or reduce or remove its reactivity or hazardous nature in any way, either chemically or physically.

Both the flowing fluid and the desensitizing fluid may be either a liquid or a gas. Normally, however, at least the desensitizing fluid will be a liquid, in which case the pressure sensing means will monitor the change in hydrostatic pressure due to movement of the enclosed fluid as the volume of enclosure changes.

The pressure sensing means may be any conventional type, for example a gas pressure gauge communicating with a desensitizing gas within the enclosure or a pressure sensitive device immersed in a liquid desensitizing material with a connection to an external meter or gauge. Most conveniently the pressure indicating means comprises a simple U-tube manometer in communication with the enclosure. The U-tube may be open to the atmosphere or may be sealed, with a gas-filled chamber of suitable volume above the liquid level in the manometer. By either of these arrangements hydraulic locking of the valve is avoided. In the former case changes in pressure within the enclosure are detected by changes in the level of the liquid in the open side of the manometer, while in the latter case the changes in pressure may be detected by the same means or by measuring the pressure of the gas in the sealed chamber above the liquid.

The sealing means which seals off the enclosure from the sensitive flowing fluid material must be deformable to allow for some degree of movement therein caused by the travel of the valve spindle as the valve is actuated. This movement will generally bring about changes in the volume of the enclosure within the sealing means so that the pressure of the desensitizer material at any given level relatively to the valve chamber will also change. Such change will be registered by the pressure indicating means and hence an indication will be provided of the position of the valve member and hence of the extent of valve opening. Preferably the sealing means is sufficiently inelastic for the volume of the enclosure to be influenced only by the valve position as described and not to be affected by the hydrokinetic pressure of the flowing fluid material. The effect of the latter will of course only arise once the valve is open and the fluid material is flowing through the valve chamber. If the sealing means is elastic, it will be apparent that the calibration of valve opening will take into account the effect of the hydrokinetic pressure and thus the calibration will be different for different flowing fluid pressures. This requirement for recalibration with different flowing fluid material pressure is avoided where the sealing means is inelastic and this situation is preferred. Thus most conveniently the sealing means comprises a metal bellows or a rigid plastics bellows or diaphragm. Naturally the material of which the bellows are made should in any instance be such as will not be affected by either the flowing fluid material or the liquid desensitizer material.

In the case where the sealing means comprises a bellows this conveniently extends around the valve spindle from the walls of the valve chamber adjacent the spindle to some point along the spindle which may be as far as the valve member at the end of the spindle. The bellows should not

however interfere with the flow of the flowing fluid through the valve chamber. Typically the bellows may be made of phosphor bronze or austenitic weldable stainless steel.

Where the sealing means is inelastic, the pressure indicating means can also be used to detect leaks in the sealing means. This is because with an inelastic sealing means, a pressure differential can exist across it, so that if a leak develops, the pressure of the desensitizer liquid within the enclosure will either fall or rise depending upon whether the pressure of the flowing fluid material at the sealing means is lower or higher than the pressure of the desensitizer liquid. If the two pressures are the same of course, then there will be no flow of fluid either into or out of the enclosure, but such a coincidental situation could not exist at all states of opening of the valve and can in any case, if desired, be avoided by, for example, artificially pressurizing the desensitizer material.

Where, then, an indication of leaks in the sealing means can be obtained, this can be used as the basis of an automatic warning system for leaks. Thus where, for example, the pressure indicating means is a simple U-tube manometer, the limits of the liquid level in the tube for the full range of valve openings can be established and then a pair of liquid level sensors can be set to detect levels in the tube just above the upper (normal) limit and just below the lower (normal) limit.

In the event of a leak occurring, this will then be automatically detected by the liquid level sensors at least when the valve is in the completely closed or completely open position and the leak is in the appropriate direction. If the leak is considerable then it may be detectable over a relatively short period of time even when the valve is operating at an intermediate position or when the leak is in the 'wrong' direction, i.e. into the enclosure with the valve fully closed or out of the enclosure with the valve fully open. In these cases of course the automatic warning would not be tripped until the leak had more than compensated for the pressure change effect of a full travel of the valve from fully open to fully closed or vice versa as the case may be. However, it will be apparent that by using more complex warning systems leaks occurring at any state of the valve can in fact be detected and a warning given.

It is most important to note however that the arrangement of this invention provides protection against leakage in the sealing means as well as providing indication of such leakage. Thus apart from the barrier which the liquid desensitizer of itself presents to prevent the flowing fluid material from reaching the aperture for the spindle and possible leaking out of the valve altogether, should some of the flowing fluid material actually manage to penetrate the sealing means it will be rendered harmless by the liquid desensitizer materials within the sealing means. Thus no danger can arise from leakage of the sealing means even if the enclosure within the sealing means is in open communication with the outside of the valve.

Where the flowing fluid material is sensitive to shock, it may be advantageous to use a system in which there is direct communication between the enclosure and the pressure indicating means or alternatively to provide a second enclosure outside the valve chamber which is in communication with the enclosure lying within the valve chamber. With this feature, a guard against shocks arising in the valve can be arranged by the simple method of ensuring that the means of communication is restricted. With a restricted passageway through which the liquid desensitizer passes with changing valve position, the rate of movement of the valve spindle and valve member may be limited as desired so as to prevent any shocks from occurring in the valve chamber, particularly as the valve moves into the closed position. It should be noted though that where the desensitizer liquid has either high vapour pressure or a low maximum tensile stress, then boiling or cavitation may set a limit to the available damping force when this relies on suction of the liquid through the restricted passageway. To overcome this problem it may then be preferable that the valve actuation be reversed so that the desensitizer liquid is instead forced through the passageway under an applied pressure as the valve moves towards the closed position. In whatever way it is achieved, this damping effect is particularly useful, when for example liquid explosives such as nitroglycerine are being pumped.

In a typical valve according to the invention, the sensitive flowing fluid material may be nitroglycerine and the liquid desensitizer material may be triacetin, but the valve is equally useful for controlling the flow of other hazardous fluid materials, including gases and solutions. The desensitizer liquid may also be a solution of a substance rather than a pure substance.

The invention will now be further described by reference to a particular embodiment thereof, designed for use with nitroglycerine as the fluid material and triacetin as the liquid desensitizer material. The valve assembly is illustrated in the accompanying drawing.

The main part of the assembly consists of two body portions, an upper portion 1 and a lower portion 2 (see Figure) clamped together by means of a threaded ring 3 screwed onto the upper end of the portion 2. The upper body portion 1 has a centrally positioned bore 4 expanding into a headspace 5 of somewhat greater section. Passing through the bore and headspace is a valve spindle 6 connected at its lower end to a valve member 7. The spindle carries an O-ring seal 8 bearing against the inside of base 4 in the body part 1 and is connected at its upper end to means (not shown) for moving the spindle up and down. An inlet connector 9 is bolted to the bottom of the body portion 2 and carries an inlet 10 connecting with a tapered valve seat 11. When the valve

member 7 is fully home in the seat no fluid can pass through the valve assembly. When the valve member is withdrawn from the valve seat by upward movement of the valve spindle 6, fluid is enabled to flow in through inlet 10 and through the bore forming seat 11 and into a chamber 12 within the lower body portion 2. Chamber 12 connects with outlet 13 in outlet connector 14 which is bolted to the body portion 2. Sealing to the body member is provided for the inlet and outlet connectors by means of O-rings 15 and 16 respectively. Between headspace 5 and chamber 12 is situated a fixed ring 17 through the centre of which passes spindle 6. The ring 17 is sealed to the inside of lower body portion 2 which is closely fits, with O-ring 18. The upper face of ring 17 abuts the lower face of body portion 1 and attached to its underside is a bellows 19. The bellows 19 extend down to and are affixed to the valve member 7 and thus form an enclosure 20 around valve spindle 6. Enclosure 20 is in communication with the headspace 5 via a pair of bores 21, 21', in ring 17. The diameter of the boers 21, 21' is chosen to regulate the movement of the valve spindle to avoid shocks occurring by too rapid opening or closing of the valve. Factors affecting this choice include the viscosity of the sensitizer liquid and the strength of the bellows and of the force applied to the spindle.

The top of headspace 5 has an outlet 22 through which the enclosure comprising enclosure 20 and headspace 5 (connected via bores 21 and 21') communicates via tubing 23 with a U-tube manometer (not shown).

The assembly described may be made of stainless steel except for the inlet and outlet valve members which, for the intended use, are preferably mde of PTFE. For other uses of course other materials may be suitable or even preferred. Also other valve systems may be employed such as simple flap or plate valves or ball and cup types, for example. It will be readily apparent also that whatever valve closure arrangement is used should be operable by a simple backwards and forwards movement since rotation of the valve spindle is not possible on account of the sealing means attached to it and to the valve chamber. Well known means might therefore be provided, outside the valve chamber, for converting a rotary movement of a valve wheel to a straightforward longitudinal motion of the spindle 6.

When in use the valve inlet and outlet members 9 and 14 of the valve illustrated are connected into a nitroglycerine supply line and the enclosure 20, headspace 5 and connected manometer are filled to a convenient level with triacetin. When the valve is opened, bellows 19 are compressed leading to a reduction of the volume of enclosure 20 and forcing triacetin through bores 21, 21' into headspace 5. Triacetin flows out of the headspace 5 through opening 22 and forces up the liquid level in the manometer connected at 23. The reverse process occurs when the valve member is moved back down to seat in bore 11 and close the valve.

It will be apparent that a variation of this valve assembly could be produced in which the valve actuation is reversed so that the valve member is situated outside the valve chamber 12 and the valve is closed by the upward movement of the valve member to engage a downward facing valve seat. In this embodiment the volume of enclosure 20 is increased when the valve is opened, the triacetin level in the manometer connected at 23 consequently dropping.

It will also be appreciated that changes in the pressure of the liquid desensitizer could also be followed if headspace 5 were simply open to the atmosphere, but this is less accurate than using a separate pressure gauge and generally less desirable. In another variation, the ring 17 may have only one central bore somewhat larger than the diameter of the spindle 6, the annular space around the spindle thus acting instead of separate bores 21, 21' as the means of communication between enclosure 20 and headspace 5. These and other variations which will be readily apparent and are all to be considered as coming within the scope of the present invention.

Claims

1. A valve assembly for controlling the flow of sensitive (as hereinbefore defined) flowing fluid material, which assembly comprises a chamber having an inlet and an outlet through which the fluid material to be controlled may pass, a valve member co-operative with either the inlet or the outlet to control the flow of said fluid material, a valve spindle attached to the valve member for actuation thereof, said valve spindle extending to the outside of the valve chamber through an opening therein, sealing means disposed within the chamber and attached to the valve spindle or member and to a wall of the chamber to form an enclosure around said spindle, which enclosure is sealed off from said chamber and may receive a fluid material which is a desensitizer (as hereinbefore defined) for said sensitive fluid material, and means for indicating changes in the pressure of such fluid material within the enclosure.

2. A valve assembly as claimed in claim 1 wherein the desensitizing fluid is a liquid.

3. A valve assembly as claimed in either claim 1 or claim 2 in which the sealing means is a bellows.

4. A valve assembly as claimed in claim 3 in which the sealing means is a bellows made of metal or rigid plastics material.

5. A valve assembly as claimed in claim 4 in which the bellows is made of phosphor bronze or austenitic weldable stainless steel.

6. A valve assembly as claimed in either claim 1 or claim 2 in which the sealing means is a diaphragm.

7. A valve assembly as claimed in any preceding claim in which the means for indicating changes in pressure of the enclosed fluid material comprises a U-tube manometer.

8. A valve assembly as claimed in claim 7 in which the U-tube manometer is connected to a gas reservoir.

9. A valve assembly as claimed in any preceding claim in which the pressure indicating means communicates with the enclosure around the spindle via a second enclosure outside the valve chamber.

10. A valve assembly as claimed in claim 9 in which said communication is restricted so as to provide a damping effect on flow of the enclosed fluid.

11. A valve assembly as claimed in any of the preceding claims in which the valve actuation is reversed so that the enclosed fluid is forced through the communication into the pressure indicating means when the valve moves towards the closed position.

12. A valve assembly as claimed in any preceding claim in which the flowing fluid is a liquid.

13. A valve assembly as claimed in claim 12 in which the liquid is nitroglycerine or nitroglycerine solution.

14. A valve assembly as claimed in any preceding claim in which the desensitizing fluid is triacetin, or a solution of triacetin.

15. A valve assembly substantially as hereinbefore described with reference to the accompanying diagram.

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